

REMARKS

The Rejections Under 35 USC § 112, second paragraph

The rejections to the form of the claims are rendered moot by the claim amendments.

The specification teaches that TPAA1 is not a trademark, but is a triarylamine compound of Formula 18 depicted on page 57 of the application. Said formula is not inserted into the claims.

The specification teaches at the top of page 55 that TopasTM 8007 is a linear olefin and cycloolefin(norbornene)copolymer. The generic description of this trademarked product is inserted into the claims.

Obviousness-type Double Patenting Rejection

A terminal disclaimer is filed over 11/671,877 rendering this rejection moot.

The Rejections Under 35 USC § 102

Claims 1-5 and 9-22 are rejected as allegedly anticipated by Brown et al., WO 02/451,184, U.S. 7,095,044.

Claim 1 is amended by reciting that "at least one of R₁ to R₁₂ is an optionally substituted C₁-C₄₀ hydrocarbyl group that is a saturated or unsaturated acyclic group, or a saturated or unsaturated cyclic group." See, e.g., original claim 5.

Brown et al. does not disclose a formulation comprising a substituted polyacene of formula A, wherein the polyacene comprises at least one substituent R₁ to R₁₂ as defined in claim 1. The only place where the term "polyacene" is mentioned in Brown et al. is on page 4, line 28 of WO '184, in a list of possible "other organic semi-conducting materials" which list extends from page 4, line 28 to about the middle of page 5, and discloses a huge number of compounds and classes of compounds generically. Moreover, no substituents are mentioned for said "polyacene" in Brown et al.

Thus, the formulations of the claims are therefore not anticipated by Brown et al.

The Rejections Under 35 USC § 103

The Office Action rejects the claims as allegedly unpatentable over Minakata, WO 03/016599, US 7,095,044, in view of Brown et al.

The Office Action alleges that since Minakata teaches substituted polyacenes, and Brown et al. teaches formulations comprising an organic binder, the person skilled in the art

would have been motivated to combine the teachings of these references to arrive at the claimed invention.

However, there is no reason or motivation for the person skilled in the art to combine the teachings of Minakata and Brown et al. A combination of these references to arrive at the present invention could only be made in hindsight. This is especially so because Minakata teaches away from the present invention.

Minakata teaches the use of a substituted polyacene in its pure, crystalline state in a semiconductor layer. Consequently, Minakata teaches to use a substituted polyacene with better solubility, which enables the formation of semiconducting films from solution, e.g. by slow and controlled precipitation from an organic solvent, to yield films with higher crystallinity (see column 6, lines 4-39, especially lines 24-39 and column 6, line 66 - column 7, line 4 of Minakata). See, for example, column 6, lines 37-39, specifically attributing the superior characteristics of the semiconductor due to its high crystallinity.

Following the teachings of Minakata, dilution of the polyacene in an organic binder in any way would be totally undesired, since this would have been expected to disrupt the crystalline structure of the polyacene film, and hence reduce charge mobility, which is contrary to the original intentions of Minakata.

In contrast, the present invention teaches and claims in the opposite direction (as discussed in detail, e.g., on page 1, line 35 to page 2, line 13 of the present application), as it uses substituted polyacenes in combination with an organic binder. Slow precipitation to achieve a high degree of crystallinity is not required. Moreover, when an organic semiconducting compound is mixed with a binder, it is effectively “diluted” by the binder. However, diluting the organic semiconductor by mixing it with a binder disrupts the molecular order in the semiconducting layer. Hence, one of ordinary skill in the art would expect a reduction of the charge mobility. Diluting an organic semiconductor in the channel of an organic field effect transistor, for example, is particularly problematic, as any disruption of the orbital overlap between molecules in the immediate vicinity of the gate insulator (the first few molecular layers) is expected to reduce mobility. Electrons or holes are then forced to extend their path into the bulk of the organic semiconductor, which is undesirable.

Therefore, one of ordinary skill in the art would not expect that substituted pentacenes as disclosed by Minakata could be used together with a binder with a reasonable chance of success.

In summary, whereas Minakata teaches that substituted pentacenes are useful because

they enable a highly ordered crystalline structure and close packing of the molecules, Brown et al. teaches exactly the opposite, i.e. to dilute the semiconductor and thereby destroy its crystalline structure by mixing it with an organic binder. Therefore, there is no reason or motivation for the skilled person to combine the teachings of Minakata with that of Brown et al., by mixing the substituted pentacenes of Minakata with an organic binder of Brown et al. in order to arrive at the present invention. To the contrary, Minakata teaches away from the present invention, as it teaches one of ordinary skill in the art away from modifying the polyacene film in any way which would disrupt its crystallinity.

However, instead of the expected decrease of charge carrier mobility, the formulation of the present invention even leads to a significant and unexpected advantage/improvement/increase in the mobility and its uniformity.

Although not necessary for overcoming the rejections for reasons discussed above, and not being relied on, applicants discuss below said significant and unexpected advantage/improvement/increase in the mobility and its uniformity over the prior art.

The formulations of the claimed invention comprise a substituted polyacene as semiconductor and an organic binder. As shown in the examples of the present application, this leads to OFET devices with high charge carrier mobility. See Tables 4 and 5 on pages 52-54, where mobilities ranging from $0.16 \text{ cm}^2/\text{Vs}$ (example 26) to $1.4 \text{ cm}^2/\text{Vs}$ (example 21) are achieved. In addition, Table 4 shows that the mobility in a transistor comprising a substituted polyacene with a binder (examples 12, 14) is significantly higher than in a transistor comprising the same compound without a binder (examples 13, 15). In addition, the uniformity of the mobility could be significantly improved (as illustrated by the smaller standard deviation, see discussion page 53).

The mobility values reported in the prior art references are much lower.

The examples of Brown et al. show formulations comprising polymeric semiconductors (like polytriarylamine, polyfluorene or polythiophene) and an organic binder. The charge mobilities in a transistor comprising these formulations as reported by Brown et al. are in the range from 10^{-4} to $10^{-5} \text{ cm}^2/\text{Vs}$ (see the table on page 27 of Brown et al.). The units for the mobilities are not in the table on page 27, but it is clear based on the description as a whole that the units are in cm^2/Vs (see, e.g., page 3, line 25). Thus, the mobility values achieved by the formulations of the claimed invention herein are about three to five orders of magnitude higher.

The examples 17 and 26 of Minakata show transistor devices comprising the

compound (6,13-(bis-triisopropylsilylethynyl)pentacene, which is identical to compound 1 used in examples 12, 13 and 16-20 of the claimed invention. In the devices of Minakata the compound is provided as semiconductor layer in its pure crystalline state. The mobility value of these devices as disclosed in examples 17 and 26 of Minakata is $0.12 \text{ cm}^2/\text{Vs}$. Thus, the mobility values achieved by the formulations of the claimed invention herein comprising the same compound (see examples 12, 13, 16-20 of the present specification) are about 100% to 350% higher.

The advantages/improvements discussed above could not have been expected from the teaching of the prior art references. Neither of these references discloses or suggests that a semiconductor layer comprising a substituted pentacene and an organic binder would show significantly higher mobility and increased uniformity compared to a semiconductor layer comprising the pure substituted pentacene in its crystalline state. In view of the teaching of Brown et al. and Minakata as explained above, these results were totally surprising and unexpected for the skilled person.

Reconsideration is respectfully requested.

The Commissioner is hereby authorized to charge any fees associated with this response or credit any overpayment to Deposit Account No. 13-3402.

Respectfully submitted,

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